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"Theoretical and Experimental Investigations of Electron Density and Collision Frequency in the Lower (D and E) Regions of the Ionosphere by Research Rocket Radio Transmissions During the IQSY Using Differential Absorption, Faraday Rotation, and Mass Spectrometry."

Under the direction of

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During the past six months, the Coordinated Science Laboratory participated in ionospheric experiments conducted aboard the U. S. Navy aircraft carrier Croatan at various south geomagnetic latitudes, about 70 miles off the shores of western South America. Five Nike-Apache rockets were fired in experiments to measure the electron density and collision frequency in the D layer. Two of these were fired at the magnetic equator and one each was fired at 29° , 44° , and 58° south latitude. All were successful except one of the firings at the magnetic equator, where failure was attributed to malfunctioning of a commercial telemetry transmitter.

On June 14 and 15, 1965, two more Nike-Apache rockets were successfully launched at Wallops Island, Virginia, for measuring the differential absorption and Faraday rotation for the determination of electron density and collision frequency in the D region. This brings the total number of rocket firings to 14, of which 13 were considered operationally successful. These firings bring to a close CSL's participation in this phase of the project. The experimental equipment has been transferred to a group in the Electrical Engineering Department which will continue this type of experiment under the direction of Dr. Sidney Bowhill.

One of the novel features of this experimental system has been the high sampling rate of differential absorption and Faraday rotation. However, due to laborious methods of manual data analysis, the total available data was never fully extracted from the recorded signals. The manual determination of Faraday rotation to resolutions of about one degree has been done only at a limited number of altitudes for about five experiments because of the large data processing time required. Consequently, automatic data processing methods were investigated.

During the reported period, a prototype automatic data processing system was put into operation, and the first differential absorption and Faraday rotation data was extracted from telemetry magnetic tape. To extract differential absorption, a magnetic tape containing the launch-range time signals and the extraordinary attenuator monitor voltage is played back and fed to an analog-to-digital recorder at 1/16 real time. A synchronizer unit receives the launch range time signals and changes them to a form suitable for punch command signals to the analog-digital converter. The latter unit punches out the data points in binary form whenever commanded by the synchronizer. These command pulses can be set at rates of 1, 5, or 10 pps of real time. The punched paper tape is then fed to a digital computer which prints out the extraordinary attenuator setting versus Greenwich mean time. Data which formerly took one week to extract now takes about three hours

and will be shortened to a half hour, when fully automatized. A plot of automatically extracted differential absorption versus Greenwich mean time for rocket firing 14.149 is shown in Fig. 1.

An even greater saving in time and labor has been accomplished with the automatic extraction of Faraday rotation. This system continuously measures the integrated phase shift between the ordinary and extraordinary transmitted waves. The analog-to-digital converter punches out the accumulated phase shift (Faraday rotation), upon command of the synchronizer, at a rate of 10 data points per second of real time. This punched tape is also fed to a digital computer which prints out the Faraday rotation versus Greenwich mean time. At the present time, phase corrections due to a filter component must be made to the Faraday rotation extracted by this method in regions where the rocket spin rate is varying--usually only near the start of the Faraday rotation. Fig. 2 shows a comparison of the Faraday rotation obtained by manual and by automatic methods, together with the rocket spin frequency versus Greenwich mean time for flight number 14.149, before phase corrections were made.

A final report, describing in detail the complete system and operational procedure, is nearing the final stages of completion.

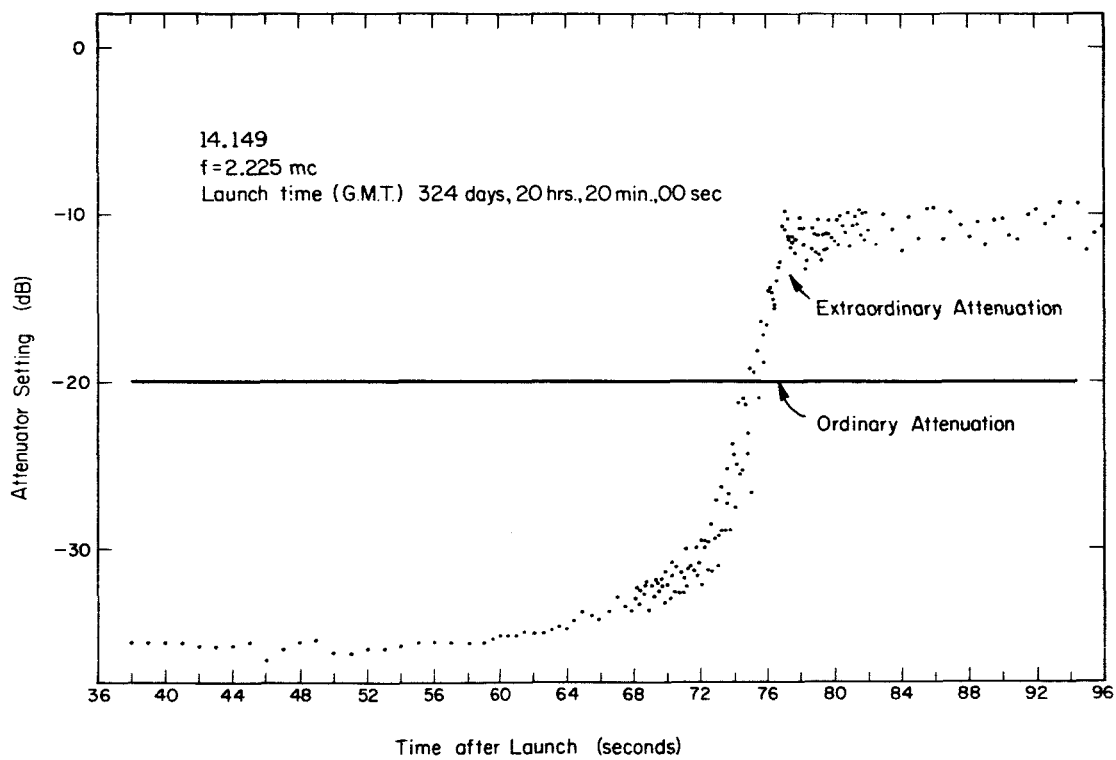


Fig. 1. Differential Absorption versus Time after Launch, Obtained by the Automatic Data Processor.

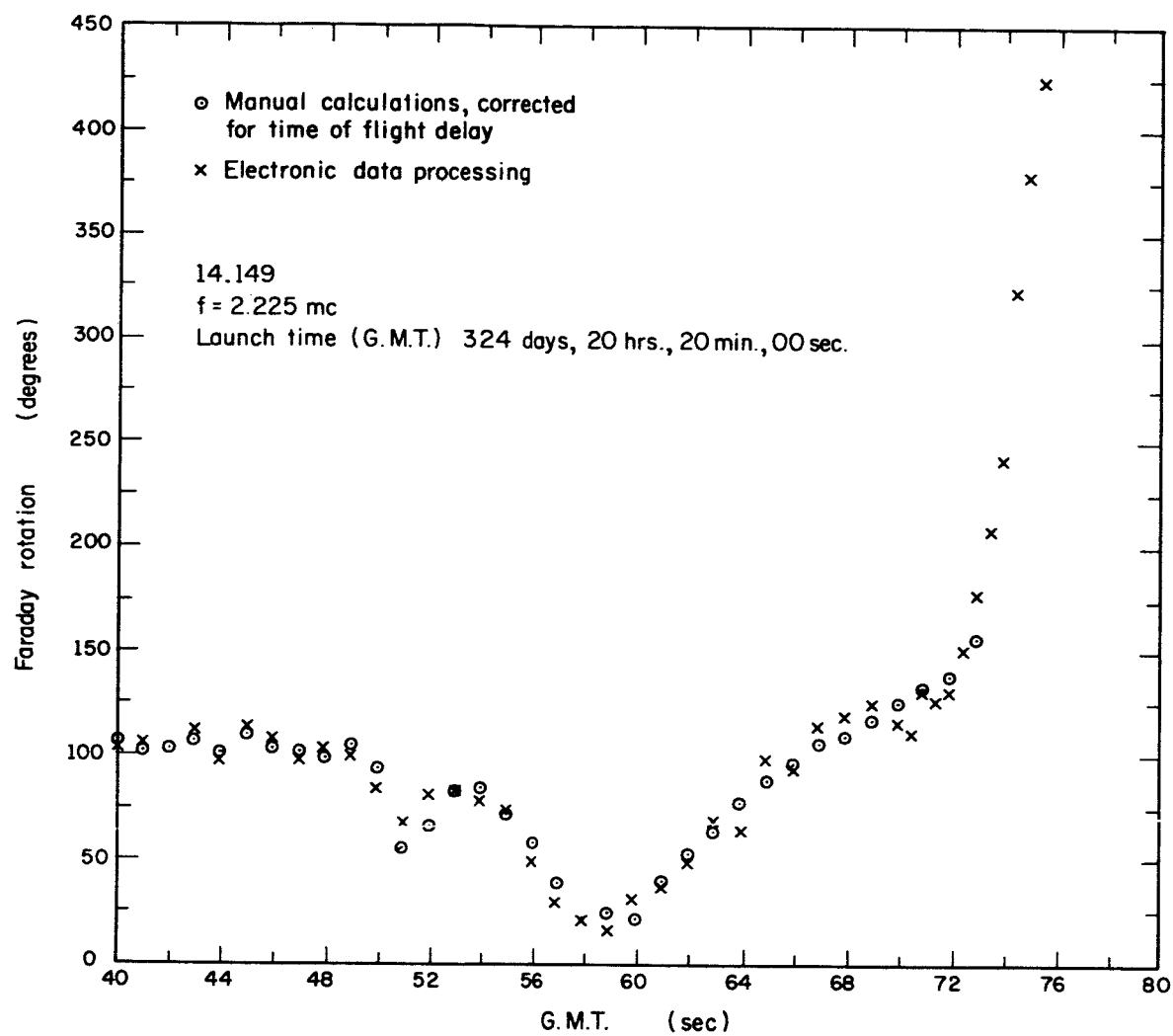


Fig. 2. Comparison of Faraday Rotation by Manual and Automatic Methods, after Phase Correction.